

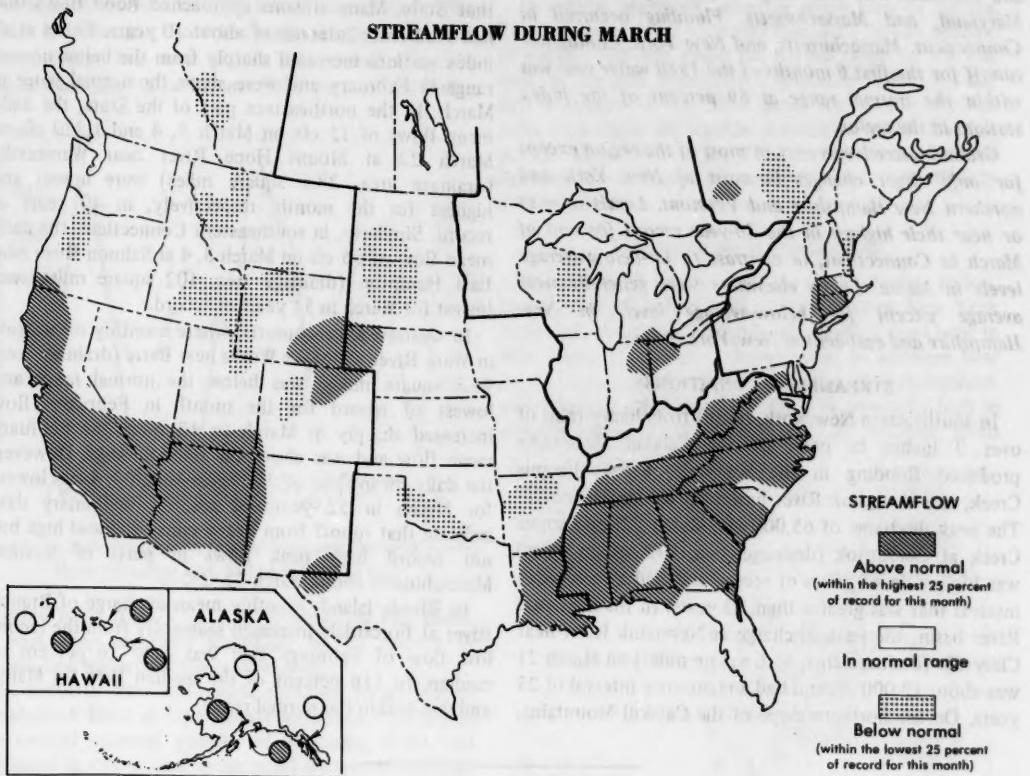
# **WATER RESOURCES REVIEW**

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

CANADA  
DEPARTMENT OF THE ENVIRONMENT  
WATER RESOURCES BRANCH

**MARCH 1980**

## **STREAMFLOW DURING MARCH**



## STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow generally increased seasonally in Hawaii, northern parts of the Midcontinent Region, and most States in the Northeast, Southeast, and Western Great Lakes Regions. Flows decreased in Alaska, Alberta, Arizona, Nevada, Oklahoma, and Texas, and were variable elsewhere.

Monthly mean flow remained above the normal range in a large area in and adjacent to Arizona, and increased into that range in parts of Connecticut, Hawaii, Indiana, Maryland, Massachusetts, Nebraska, Ohio, and in most of the Southeast Region. Monthly mean discharges were highest of record for the month in parts of Alabama and Georgia. Flooding occurred in Alabama, Connecticut, Florida, Georgia, Hawaii, Indiana, Louisiana, Massachusetts, Minnesota, Mississippi, New York, North Carolina, South Carolina, and Tennessee.

Below-normal streamflow persisted in parts of Arkansas, Alberta, Idaho, Maine, Montana, Oregon, Quebec, and Utah. Daily mean flows were lowest of record for March in parts of Connecticut and Massachusetts, and highest of record for the month in parts of Connecticut, Hawaii, and Louisiana.

Ground-water levels rose in most of the Northeast Region. Levels were close to highest in the 30-year record for March in Connecticut, in contrast to far-below-average levels in Maine. Elsewhere, levels were generally near average, but were below average locally in New Hampshire and east-central New York. In the Southeast Region, rising trends and above-average levels prevailed except locally. In the Western Great Lakes Region, levels rose in Indiana and Ohio, and trends were mixed in other States; levels were average in Indiana, and above and below average elsewhere. In the Midcontinent Region, levels rose in North Dakota and Nebraska, but trends were mixed elsewhere. Levels were mostly below average. In the West, levels rose in Utah and generally declined in Montana and New Mexico; elsewhere, trends were mixed. Levels were below average in Montana, Arizona, and New Mexico, and mostly below average in Idaho; levels were mixed with respect to average elsewhere.

New high ground-water levels for March occurred in Alabama, Kentucky, Utah, and West Virginia, and new alltime highs were reached in southern California and Kentucky. New low levels for March were recorded in Arizona, Arkansas, Idaho, Kansas, Louisiana, Maine, Nevada, and New Mexico, and new alltime low levels occurred in Idaho and Texas.

## NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

*Streamflow increased seasonally in all States in the region and was variable in the Atlantic Provinces and Quebec. Monthly mean flows remained in the below-normal range in parts of Quebec and Maine. Mean flows remained in the above-normal range in parts of Quebec and increased into that range in parts of Connecticut, Maryland, and Massachusetts. Flooding occurred in Connecticut, Massachusetts, and New York. Cumulative runoff for the first 6 months of the 1980 water year was within the normal range at 69 percent of the index stations in the region.*

*Ground-water levels rose in most of the region except for only slight changes in most of New York and northern New Hampshire and Vermont. Levels were at or near their highest in the 30-year record for end of March in Connecticut, in contrast to far-below-average levels in Maine. Levels elsewhere were generally near average except for below-average levels in New Hampshire and east-central New York State.*

### STREAMFLOW CONDITIONS

In southeastern New York, runoff from heavy rains of over 9 inches in parts of the Catskill Mountains produced flooding in the Schoharie Creek, Esopus Creek, and Neversink River basins on March 21 and 22. The peak discharge of 65,000 cfs, March 22, on Esopus Creek at Coldbrook (drainage area, 192 square miles) was highest in 65 years of record and had a recurrence interval that was greater than 50 years. In the Delaware River basin, the peak discharge at Neversink River near Claryville (drainage area, 65.6 square miles) on March 21 was about 12,000 cfs and had a recurrence interval of 25 years. On the northern slope of the Catskill Mountains,

the peak discharge of 55,000 cfs at Schoharie Creek at Burtonsville (drainage area, 883 square miles) was second highest in 40 years of record. Elsewhere in the State, monthly mean flows at index stations increased sharply from the below-normal flows of February, were near or slightly above median, and within the normal range.

In Connecticut, severe flash flooding was reported by the National Weather Service on March 21 as a result of runoff from almost 6 inches of rain in some sections of that State. Many streams approached flood flows that had recurrence intervals of about 10 years. Flows at all index stations increased sharply from the below-normal range in February and were above the normal range in March. In the northeastern part of the State, the daily mean flows of 12 cfs on March 3, 4 and 1,320 cfs on March 22 at Mount Hope River near Warrenville (drainage area, 28.6 square miles) were lowest and highest for the month, respectively, in 40 years of record. Similarly, in southeastern Connecticut, the daily mean flow of 55 cfs on March 3, 4 at Salmon River near East Hampton (drainage area, 102 square miles) was lowest for March in 51 years of record.

In western Massachusetts, where monthly mean flow in Ware River at Intake Works near Barre (drainage area, 96.8 square miles) was below the normal range and lowest of record for the month in February, flow increased sharply in March to 10 times the February mean flow and was above the normal range. However, the daily mean flow of 31 cfs on March 3, 4 was lowest for March in 52 years of record. Preliminary data indicate that runoff from heavy rains produced high but not record high peak flows in parts of western Massachusetts about March 22, 23.

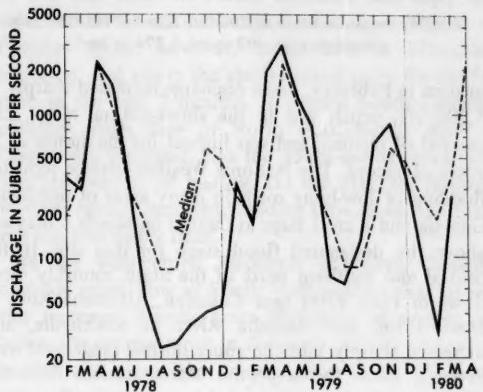
In Rhode Island, monthly mean discharge of Branch River at Forestdale increased seasonally from the record low flow of February that was only 26 percent of median, to 116 percent of the median flow for March and was within the normal range.

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In New Hampshire and Vermont, monthly mean flows at index stations increased seasonally, were less than the median flows for March, but were within the normal range.

In southern Maine, monthly mean discharge of Little Androscoggin River near South Paris increased to 59 percent of median but remained in the below-normal range for the 2d consecutive month. In the central part of the State, where monthly mean flow of Piscataquis River near Dover-Foxcroft was lowest of record for the month in February, flow increased sharply, remained below-median, but was within the normal range in March. (See graph.) In the northern part of the State,



Monthly mean discharge of Piscataquis River near Dover-Foxcroft, Maine (Drainage area, 297 sq mi; 769 sq km)

monthly mean flow of St. John River below Fish River, at Fort Kent increased seasonally to 73 percent of median and was within the normal range.

In northern New Brunswick, monthly mean flow at Upsilonquitch River at Upsilonquitch decreased, contrary to the normal seasonal pattern of increasing flows, but remained in the normal range at 85 percent of median. Elsewhere in the Atlantic Provinces, monthly mean flows at index stations generally increased sharply from the below-normal streamflow of February and were within the normal range during March.

South of the St. Lawrence River in southern Quebec, mean flow at the index station, St. Francois River at Hemmings Falls, increased sharply from the record low flow at that site during February, but remained in the below-normal range and was only 60 percent of the March median flow. North of the St. Lawrence River in southwestern Quebec, monthly mean discharge of St. Maurice River at Grand Mere increased seasonally to 50 percent of median and remained in the below-normal range for the 3d consecutive month. Also in southwestern Quebec, mean flow of Harricana River at Amos

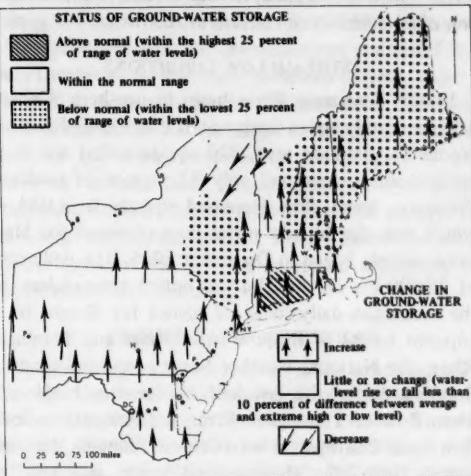
continued to decrease seasonally but remained in the above-normal range for the 11th consecutive month as a result of high carryover flow. Elsewhere in the Province, mean flows at index stations were within the normal range and generally less than median.

In New Jersey and Pennsylvania, monthly mean discharges at all index stations increased seasonally, were within the normal range, and near the median flows for March at most sites.

In central Maryland, monthly mean flow of Seneca Creek at Dawsonville increased seasonally to 135 percent of median and was above the normal range for the 6th time in the past 8 months. Cumulative runoff for the first 6 months of the 1980 water year at that site was more than twice the median cumulative runoff for that period. Elsewhere in the State, mean flows at index stations also increased seasonally but were only slightly above median.

#### GROUND-WATER CONDITIONS

Ground-water levels rose in most of the region. However, levels fell in part of northeastern New York State and generally changed only slightly elsewhere in New York, in northern Pennsylvania, in southern New Jersey, and in much of northern Maine, New Hampshire, and Vermont. (See map.) Levels were unusually high in central and southern Connecticut. By contrast, levels



Map shows ground-water storage near end of March and change in ground-water storage from end of February to end of March.

were below average throughout Maine, including some wells where the levels were lowest of record for end of March in the past 30 to 40 years. Levels were below average also in New Hampshire and in east-central New York State, and near average elsewhere.

## SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

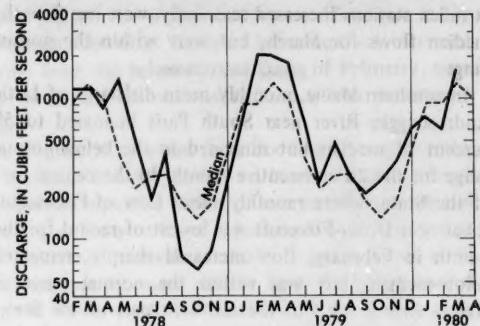
*Streamflow decreased, contrary to the normal seasonal pattern, in parts of southern Florida, but increased in all other parts of the region. Monthly mean flows increased into the above-normal range in parts of all States except Kentucky, and were highest of record for the month in parts of Alabama and Georgia. Mean flows for March were above the normal range at 94 percent of the index stations in the region. Flooding was reported to have occurred in parts of Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. Cumulative runoff for the first 6 months of the 1980 water year was above the normal range at 69 percent of the index stations in the region.*

*Ground-water levels generally rose in the region except for local declines in West Virginia, North Carolina, Georgia, and Florida. Above-average levels prevailed, but were below average in parts of West Virginia and Florida, and in the key well in Memphis in western Tennessee. New high levels for March were reached in West Virginia, Kentucky, and Alabama, and a new alltime high occurred also in Kentucky.*

### STREAMFLOW CONDITIONS

In the Tennessee River basin in northern Alabama, where monthly mean discharge of Paint Rock River near Woodville (drainage area, 320 square miles) was in the below-normal range and only 32 percent of median in February, mean flow increased sharply to 4,034 cfs, which was the highest mean flow observed for March since records began in December 1935. The daily mean of 25,900 cfs on the 21st was only 1 percent less than the maximum daily mean of record for March. In the adjacent basins of Black Warrior River and Tombigbee River, the National Weather Service reported moderate flooding during the last half of the month. Monthly mean flow of Tombigbee River at Demopolis lock and dam, near Coatopa, in west-central Alabama, increased sharply into the above-normal range and was 238 percent of median. Similarly, mean discharge of Cahaba River at Centreville, in the central part of the State, increased sharply, was above the normal range, and was 317 percent of median. In southeastern Alabama, monthly mean flow of Conecuh River at Brantley also increased sharply but was in the normal range. (See graph.)

In the northwestern part of Georgia, where monthly mean flow of Etowah River at Canton (drainage area, 605 square miles) was in the normal range and less than



Monthly mean discharge of Conecuh River at Brantley, Ala.  
(Drainage area, 492 sq mi; 1,274 sq km)

median in February, mean discharge increased sharply to 5,200 cfs, which was in the above-normal range, 286 percent of median, and was highest for the month in 53 years of record. The National Weather Service reported flooding of low-lying roads in many areas of northwest Georgia and a crest stage at Canton on March 8 that was above the designated flood stage for that site. In the central and southern parts of the State, monthly mean flows of Flint River near Culloden, Altamaha River at Doctortown, and Alapaha River at Statenville, also increased sharply into the above-normal range, and were about 2 times the respective March median flows for those sites.

In northeastern Mississippi, monthly mean flow of Tombigbee River at Columbus increased sharply into the above-normal range, and was 316 percent of median, following a month of mean flow that was less than median. On the Pearl River flood plain in Jackson, in the central part of the State, flooding of some residences on March 16 and flooding of businesses and roadways on March 20 was reported by the National Weather Service. In the southeastern and southwestern parts of the State, respectively, monthly mean flows of Pascagoula River at Merrill and Big Black River near Bovina increased seasonally and were in the above-normal range for the 6th time in the past 7 months. Cumulative runoff at the latter station for the first 6 months of the 1980 water year was 236 percent of median.

In east-central Tennessee, where monthly mean flow of Emory River at Oakdale was below the normal range and only 34 percent of median in February, mean discharge increased sharply into the above-normal range and was 184 percent of median in March. Similarly, in the north-central part of the State, where mean flow of Harpeth River near Kingston Springs was below the normal range and only 51 percent of median in February, monthly mean discharge increased sharply, contrary to the normal seasonal pattern, was above the

normal range, and was 213 percent of median. In extreme eastern Tennessee, mean flow of French Broad River below Douglas Dam also increased into the above-normal range, following a month in the below-normal range. In the western part of the State, monthly mean discharge of Buffalo River near Lobelville increased seasonally, was 220 percent of median, and also was above the normal range. On March 21, the National Weather Service reported that some evacuation of residents had occurred throughout the State as a result of flooding caused by runoff from rainfall of up to 5 inches.

In northeastern South Carolina, monthly mean flow of Pee Dee River at PeeDee increased seasonally but remained in the normal range. In the adjacent basin of Lynches River, however, mean flow at Effingham increased, and was in the above-normal range for the 5th time in the past 7 months. In central South Carolina, monthly mean flow of North Fork Edisto River at Orangeburg increased into the above-normal range and was 168 percent of median. On the 21st, the National Weather Service reported flooding throughout the State as a result of heavy rains.

In the west-central Piedmont of North Carolina, monthly mean flow of South Yadkin River near Mocksville increased sharply, from 70 percent of median and below the normal range in February, to 161 percent of median and above the normal range in March. Some minor flooding occurred along streams in this part of the State March 20, 21. In the extreme western part of the State, mean discharge of French Broad River at Asheville also increased from the below-normal range in February into the above-normal range in March. Near bank-full stages occurred over much of the Tennessee River basin in this part of the State on the 20th and 21st. In the eastern Piedmont and Coastal Plain, monthly mean flows of Cape Fear River at William O. Huske Lock near Tarheel and Neuse River near Clayton also increased into the above-normal range and were about 1½ times the respective median discharges for those two sites.

In southeastern Virginia, monthly mean discharge of Nottaway River near Stony Creek increased, contrary to the normal seasonal pattern, and was in the above-normal range for the 15th time in the past 16 months. Cumulative runoff for the first 6 months of the 1980 water year was 2½ times median at this station. In the southwestern part of the State, mean flow of North Fork Holston River near Saltville also increased into the above-normal range, where it had been in 6 of the preceding 9 months. Similarly, in the northern part of the State, monthly mean flow of Rapidan River near Culpeper also increased into the above-normal range, where it had been in 6 of the preceding 9 months.

In eastern West Virginia, where mean flow of Greenbrier River at Alderson was below the normal range and only 53 percent of median in February, monthly mean discharge increased sharply as a result of increased runoff from rain and melting snow near midmonth, was in the above-normal range, and was 1½ times the March median discharge. In the southwestern part of the State, mean discharge of Kanawha River at Kanawha Falls also increased sharply and was above the normal range, following 3 consecutive months of mean flow within the normal range. In extreme northern West Virginia, monthly mean flow of Potomac River at Paw Paw increased seasonally but remained in the normal range for the 4th consecutive month.

In northeastern Florida, flooding occurred at month-end in St. Johns River basin below Oklawaha River, where a peak discharge equal to that of a 15-year flood occurred March 31 on North Fork Black Creek near Middleburg. Residents of homes built on the flood plains of that stream were forced to evacuate and property damage was reported to have been extensive. Flood peaks equal to those of a 10-year flood were reported to have occurred on other tributaries of St. Johns River south of Jacksonville. In the panhandle area of northern Florida, flooding along the Apalachicola and Chipola Rivers was reported by the National Weather Service during the latter part of the month. Monthly mean flows of Apalachicola River at Chattahoochee and Shoal River near Crestview, in that area, increased sharply, were 1½ times their respective median discharges for March, and were in the above-normal range. In central and southern parts of the State, respectively, mean flows of Pearl River at Arcadia and Fisheating Creek at Palmdale decreased, contrary to the normal seasonal pattern, and remained within the normal range. Elsewhere in the State, monthly mean flows increased seasonally but remained within the normal range.

#### GROUND-WATER CONDITIONS

In West Virginia, ground-water levels continued about the same in the western two-thirds of the State. Levels declined in Berkeley, Jefferson, and Preston Counties, but rose elsewhere. Levels were below average in a few northeastern and eastern counties but were near or above average elsewhere. A new March high level, in 27 years of record, was reached in the water-table observation well in Glenville, in Gilmer County, in the Central Appalachian Plateaus Region.

In Kentucky, levels generally rose and were above average statewide. Heavy rains near month-end caused levels to rise sharply in observation wells near high-stage rivers and streams. The level in the artesian observation well in the Jackson Purchase region rose slightly to a

new high for March in 29 years of record. The level in the water-table key well in Louisville, Jefferson County area, declined very slightly but was at a new alltime high in 34 years of record.

Levels in Virginia held steady or rose slightly and were nearly a foot to 5 feet above average.

In western Tennessee, the artesian level in the key well in the "500-foot sand" near Memphis rose slightly and continued nearly 15 feet below average.

In North Carolina, levels rose in the mountains and in the Piedmont, but declined in the Coastal Plain. Levels were above long-term averages across the entire State.

Ground-water levels rose slightly in artesian aquifers statewide in Mississippi; levels in shallow water-table aquifers rose moderately in response to heavy March rainfall.

Levels rose statewide in Alabama. A new March high level in the key well at Centreville, Bibb County, was in part influenced by high water in the Cahaba River nearby.

In Georgia, levels in the Piedmont rose as much as 2 feet, while those in the principal artesian aquifer in the coastal counties declined as much as 3 feet. Levels in the water-table aquifers in the latter area were a little below average in early March but were as much as 2 feet above average at month's end. In the southwest, levels in key wells rose as much as 10 feet.

In Florida, levels rose in the northwest but declined in many areas in the central and southern parts of the State; month-end levels ranged from nearly 3 feet above to nearly 4 feet below those of the end of February. Levels ranged from 2 feet above average in the north to 4 feet below average in the central and northeast parts of the State. In southeastern Florida, levels declined less than  $\frac{1}{2}$  foot and ranged from  $\frac{1}{2}$  foot above average in Dade County to about average in St. Lucie County.

## WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

*Streamflow decreased in parts of Ontario, Minnesota, and Wisconsin, and increased seasonally elsewhere in the region. Monthly mean flows increased into the above-normal range in parts of Indiana and Ohio, decreased into the below-normal range in parts of Wisconsin, and were within the normal range at 85 percent of the index stations in the region. Cumulative runoff for the first 6 months of the 1980 water year was above the normal range at 30 percent of the index stations in the region and was generally within the normal range elsewhere in the region. Flooding occurred in Indiana and Minnesota.*

in relation to runoff. The new low water level declined sharply to well below seasonal median discharge, which was below normal for the month in most of the region.

**Ground-water levels declined and held steady in Minnesota, rose in Indiana and Ohio, and showed mixed trends in Wisconsin and Michigan. Levels were average in Indiana, but were generally above and below average elsewhere in the region.**

## STREAMFLOW CONDITIONS

In northeastern Indiana, where monthly mean flow of Mississinewa River at Marion was only 59 percent of median in February, mean discharge increased sharply and was above the normal range as a result of runoff from rain and melting snow. At other index stations in the State, monthly mean discharges increased seasonally but remained within the normal range. The National Weather Service reported extensive lowland flooding along the Wabash and White Rivers, and low farmlands generally were inundated during much of the month.

In southeastern Minnesota, runoff from rain and melting snow at midmonth broke up ice on many streams and the resulting ice jams caused flooding of several roads. On March 19, the National Weather Service reported that Zumbro River at Theilman, in southeastern Minnesota, crested 0.2 foot over the designated flood stage of 38 feet. In southwestern Minnesota, monthly mean flow of Minnesota River near Jordan increased seasonally but was slightly below the above-normal range, following 8 consecutive months of mean flow in that range. Cumulative runoff at that station for the first 6 months of the 1980 water year was 267 percent of median. In Lake of the Woods basin, in extreme northern Minnesota, mean flow of Rainy River at Manitou Rapids decreased seasonally and was less than median for the first time since October 1979, but remained in the normal range.

In southeastern Ontario, where monthly mean flow of Saugeen River near Port Elgin was only 55 percent of median and in the below-normal range in February, mean discharge increased seasonally, was greater than median, and was in the normal range. In the eastern and western parts of the Province, mean discharges of Missinaibi River at Mattice and English River at Umfreville, respectively, decreased seasonally and were less than median but remained within the normal range.

In eastern Wisconsin, monthly mean flow of Fox River at Rapide Croche Dam, near Wrightstown decreased sharply, contrary to the normal seasonal pattern of increasing flow, was only 53 percent of median, and was in the below-normal range for the first time since March 1978. In the north-central part of the State, mean discharge of Oconto River near Gillett increased seasonally but was only 79 percent of median and was below the normal range for the first time since March 1978. Elsewhere in Wisconsin, mean flows at other index stations increased seasonally and were within the normal range but were less than median.

(Continued on page 8.)

Provisional data: subject to revision

**SELECTED DATA FOR THE GREAT LAKES, GREAT SALT LAKE, AND OTHER HYDROLOGIC SITES**

**GREAT LAKES LEVELS**

Water levels are expressed as elevations in feet above International Great Lakes Datum 1955

(Data furnished by National Ocean Survey, NOAA, via U.S. Army Corps of Engineers office in Detroit. To convert data to elevations above mean sea level datum of 1929, add the following values: Superior, 0.96; Michigan-Huron, 1.20; St. Clair, 1.24; Erie, 1.57; Ontario, 1.22.)

Lake	March 31, 1980	Monthly mean, March		March		
		1980	1979	Average 1900-75	Maximum (year)	Minimum (year)
Superior . . . . .	600.25	600.26	600.04	599.99	600.97 (1975)	598.32 (1926)
(Marquette, Mich.)						
Michigan and Huron . . . . .	578.99	578.96	578.43	577.74	579.98 (1973)	575.35 (1964)
(Harbor Beach, Mich.)						
St. Clair . . . . .	575.12	574.56	574.09	572.68	575.75 (1973)	570.41 (1934)
(St. Clair Shores, Mich.)						
Erie . . . . .	572.27	571.69	570.90	569.95	572.88 (1973)	567.65 (1934)
(Cleveland, Ohio)						
Ontario . . . . .	244.84	244.27	244.78	244.34	246.77 (1952)	242.08 (1935)
(Oswego, N.Y.)						

**GREAT SALT LAKE**

	March 31, 1980	March 31, 1979	Reference period 1904-79		
			March average, 1904-79	March maximum (year)	March minimum (year)
Alltime high: 4,211.6 (1873). Alltime low: 4,191.35 (October 1963).					
Elevation in feet above mean sea level:	4,199.20	4,199.65	4,198.70	4,204.90 (1924)	4,192.40 (1963)

**LAKE CHAMPLAIN, AT ROUSES POINT, N.Y.**

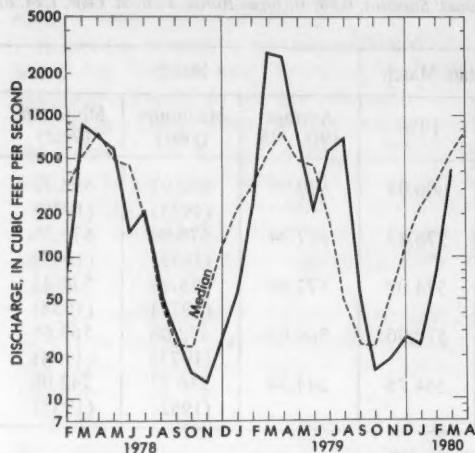
	March 28, 1980	March 31, 1979	Reference period 1939-78		
			March average, 1939-78	March max. daily (year)	March min. daily (year)
Alltime high (1827-1977): 102.1 (1869). Alltime low (1939-1977): 92.17 (1941).					
Elevation in feet above mean sea level:	95.51	99.32	96.02	100.68 (1976)	93.63 (1940)

**FLORIDA**

Site	March 1980		February 1980	March 1979
	Discharge in cfs	Percent of normal	Discharge in cfs	Discharge in cfs
Silver Springs near Ocala (northern Florida) . . . . .	770	102	800	710
Miami Canal at Miami (southeastern Florida) . . . . .	150	80	175	157
Tamiami Canal outlets, 40-mile bend to Monroe . . . . .	71	1,010	93	28

(Continued from page 6.)

In Illinois, monthly mean flows at all index stations increased seasonally and were in the normal range but were less than their respective median flows for March. Typical of this statewide pattern was the mean flow of Sangamon River at Monticello, in the central part of the State. (See graph.)



Monthly mean discharge at Sangamon River at Monticello, Ill. (Drainage area, 550 sq mi; 1,424 sq km)

In northwestern Ohio, where monthly mean flow of Maumee River at Waterville was only 51 percent of median in February, mean discharge increased sharply, to 159 percent of the March median, and was in the above-normal range for the 6th time in the past 8 months. In the northeastern part of the State, where mean flow of Little Beaver Creek near East Liverpool was below the normal range and only 50 percent of median in February, mean discharge increased sharply to 132 percent of median but was in the normal range. Monthly mean flow also increased sharply in Scioto River at Highby, in central Ohio, but remained in the normal range. Storage in reservoirs in the Mahoning River basin upstream from Newton Falls was 60 percent greater than at the end of February, 12 percent greater than a year ago, and 71 percent of capacity. Storage in reservoirs in the Scioto River basin upstream from Highby was 6 percent greater than at the end of February, 3 percent less than a year ago, and 86 percent of normal capacity.

In the southern part of Michigan's Lower Peninsula, where monthly mean flow of Red Cedar River at East Lansing was below the normal range and only 56 percent of median in February, mean discharge increased seasonally and was in the normal range but remained

below median. In the Upper Peninsula, and in the northern part of the Lower Peninsula, monthly mean flows of Sturgeon River near Sidnaw and Muskegon River at Evart, respectively, increased seasonally and remained within the normal range but were less than median. Cumulative runoff of Sturgeon River near Sidnaw for the first 6 months of the 1980 water year was above the normal range. Also in the northern part of the Lower Peninsula, monthly mean levels of Crooked Lake near Conway, Houghton Lake near Houghton Lake Heights, and Lake Mitchell-Cadillac at Cadillac were, respectively, 0.88 foot, 0.27 foot, and 0.14 foot below normal.

#### GROUND-WATER CONDITIONS

Ground-water levels in shallow water-table wells in Minnesota declined and were below average. In the Minneapolis-St. Paul area, artesian levels again held fairly steady in the Prairie du Chien-Jordan and Mt. Simon-Hinckley aquifers, but continued above average.

In Wisconsin, levels declined except in the shallow aquifer in the southeast. Levels in the artesian aquifer in the southeast continued to decline.

In Michigan, levels rose in the southern half of the Lower Peninsula but declined elsewhere. Levels were generally below average in the Lower Peninsula but were above average in most parts of the Upper Peninsula.

In Illinois, the level in the shallow well in glacial drift at Princeton, Bureau County, rose nearly 3 feet and continued more than 2 feet above average.

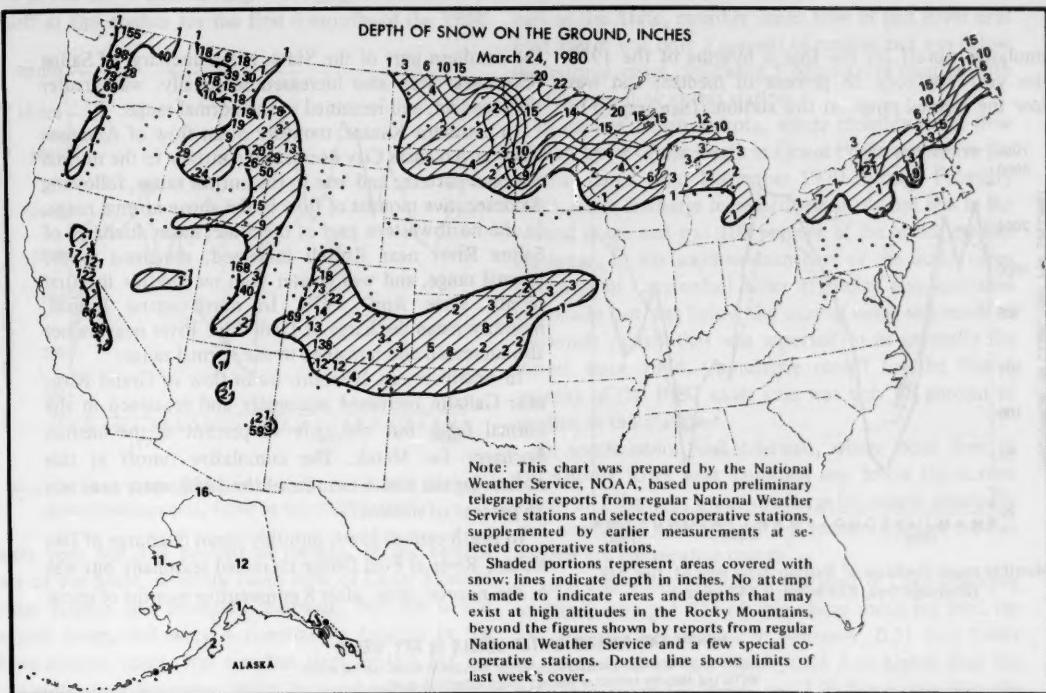
Levels in Indiana generally rose and were about average.

In Ohio, levels rose considerably and were above average in the central part of the State, but continued below average in the northeast.

#### MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

*Streamflow generally decreased in parts of Kansas, Oklahoma, and Texas, but increased elsewhere in the region. Monthly mean flows remained in the above-normal range in parts of Louisiana, and increased into that range in parts of Nebraska. Daily mean discharge was highest of record for the month in parts of Louisiana. Mean flows persisted in the below-normal range in parts of Arkansas, and monthly mean flow decreased into that range in part of Oklahoma. Flooding was in progress at monthend in Louisiana. Cumulative runoff for the first 6 months of the 1980 water year was above the normal range at 23 percent of the index*



*stations in the region and was below the normal range also at 23 percent of the stations.*

*Ground-water levels rose statewide in North Dakota but were slightly below average; they rose also in Nebraska and were near average. Mixed trends prevailed elsewhere in the region, and levels were mostly below average. New low levels for March occurred in Kansas, Arkansas, and Louisiana, and a new alltime low level was reached in the Texas Panhandle.*

#### STREAMFLOW CONDITIONS

In southeastern Louisiana, and the adjacent area of southern Mississippi, severe flooding was in progress at monthend. The peak discharge of 109,000 cfs, March 31, on Pearl River near Bogalusa, La. (drainage area, 6,630 square miles), was equal to the discharge rate of a 100-year flood, and the daily mean of 106,000 cfs on that date was the highest daily mean for March in 42 years of record. Also in southeastern Louisiana, monthly mean discharge of Amite River near Denham Springs (drainage area, 1,280 square miles) increased sharply into the above-normal range and was 246 percent of median. The daily mean of 56,800 cfs on the 30th was highest for the month in 42 years of record. In the southwestern part of the State, mean discharge of Calcasieu River near Oberlin increased seasonally, was

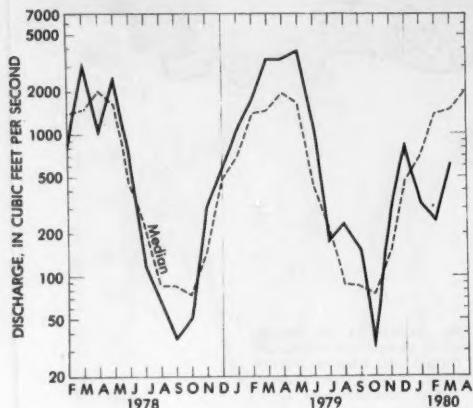
above the normal range, and was 176 percent of median. Similarly, in northwestern Louisiana, monthly mean flow of Saline Bayou near Lucky increased seasonally, was above the normal range, and was 153 percent of median. In the central part of the State, monthly mean discharge of Red River at Alexandria was only 50 percent of median and was below the normal range, and on the eastern boundary of the State, monthly mean discharge of Mississippi River at Baton Rouge was 90 percent of the median flow for March.

In Texas, monthly mean flows decreased, except in the southeastern part, where runoff from rainfall in excess of 3 inches near monthend resulted in increased flows. Mean discharges of streams in the northern third of the State were reported to be in the below-normal range. Elsewhere, mean flows were reported to be near normal. Records from 38 reservoirs in the State showed that storage increased in 10, decreased in 27, and remained the same in one.

In southwestern Oklahoma, mean flow of Washita River near Durwood decreased, contrary to the normal seasonal pattern, was below the normal range, and was only 36 percent of median. Below-normal streamflow was reported to have persisted in other parts of the State.

In northern Arkansas, monthly mean flow of Buffalo River near St. Joe increased seasonally but was only 41 percent of median and remained in the normal range.

Cumulative runoff for the first 6 months of the 1980 water year was only 38 percent of median, and was below the normal range, at this station. (See graph.) In



Monthly mean discharge of Buffalo River near St. Joe, Ark.  
(Drainage area, 829 sq mi; 2,147 sq km)

the southern part of the State, mean discharge of Saline River near Rye also increased seasonally, was greater than median, and remained in the normal range.

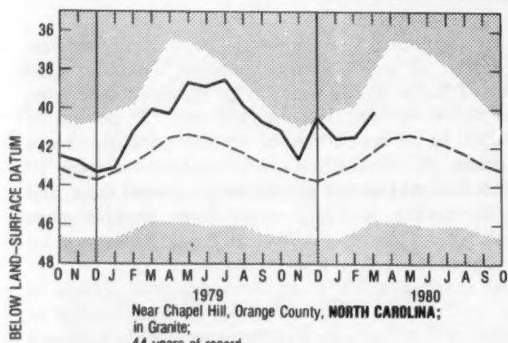
In southern Kansas, monthly mean flow of Arkansas River at Arkansas City decreased, contrary to the normal seasonal pattern, and was in the normal range, following 4 consecutive months of flow in the above-normal range. In the northwestern part of the State, mean discharge of Saline River near Russell increased, remained in the normal range, and was greater than median for the first month since April 1979. In north-central Kansas, monthly mean discharge of Little Blue River near Barnes also increased and remained in the normal range.

In northwestern Missouri, mean flow of Grand River near Gallatin increased seasonally and remained in the normal range but was only 46 percent of the median discharge for March. The cumulative runoff at this station for the first 6 months of the 1980 water year was 36 percent of median.

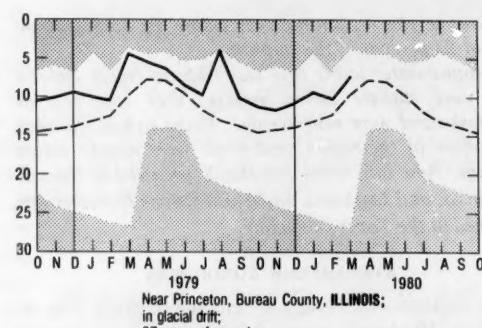
In north-central Iowa, monthly mean discharge of Des Moines River at Fort Dodge increased seasonally but was in the normal range, after 8 consecutive months of mean

#### MONTH-END GROUND-WATER LEVELS IN KEY WELLS

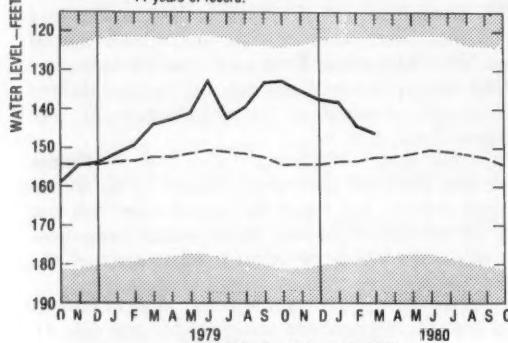
UNSHADeD AREA INDICATES RANGE BETWEEN HIGHEST AND LOWEST RECORD FOR THE MONTH  
DOTTED LINE INDICATES AVERAGE OF MONTHLY LEVELS, IN PREVIOUS YEARS  
HEAVY LINE INDICATES LEVEL FOR CURRENT PERIOD



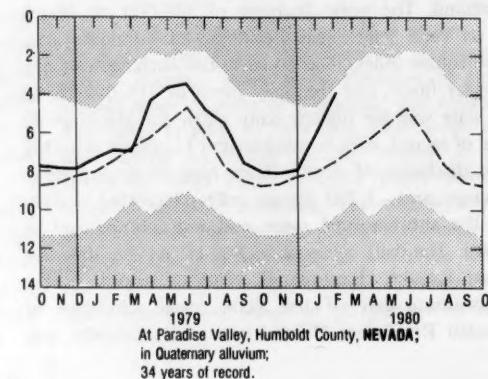
Near Chapel Hill, Orange County, NORTH CAROLINA;  
in Granite;  
44 years of record.



Near Princeton, Bureau County, ILLINOIS;  
in glacial drift;  
37 years of record.

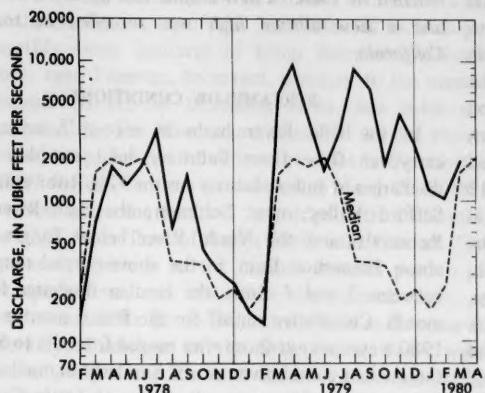


Near Buda, Travis County, TEXAS;  
in Edwards Limestone;  
36 years of record.



At Paradise Valley, Humboldt County, NEVADA;  
in Quaternary alluvium;  
34 years of record.

flow in the above-normal range. (See graph.) Cumulative runoff at this station for the first 6 months of the 1980



Monthly mean discharge of Des Moines River at Fort Dodge, Iowa (Drainage area, 4,190 sq mi; 10,852 sq km)

water year was 434 percent of median. In the eastern part of the State, monthly mean flow of Cedar River at Cedar Rapids also increased seasonally but was in the normal range, following 4 consecutive months in the above-normal range, and was less than median for the first time since February 1979. In southwestern Iowa, mean discharge of Nishnabotna River above Hamburg increased seasonally, was less than median, and remained within the normal range.

In northeastern Nebraska, monthly mean flow of Elkhorn River at Waterloo increased seasonally, remained above median, and was within the normal range. In the northwestern part of the State, mean discharge of Niobrara River above Box Butte Reservoir increased sharply and was above the normal range, following 4 consecutive months of mean flow in the below-normal range. In the North Platte River basin in western Nebraska, and in the north-central part of the State, monthly mean flows remained in the normal range. Unregulated flows in the Republican River basin, in southwestern Nebraska, were reported to be near normal. On March 7 the National Weather Service reported that a mile-long ice gorge in the Platte River south of Schuyler was causing lowland flooding.

In the Big Sioux River basin in eastern South Dakota and the adjacent areas of Minnesota and Iowa, monthly mean discharge of Big Sioux River at Akron, Iowa increased seasonally but was only 79 percent of median and was in the normal range, following 7 consecutive months of flow in the above-normal range. Cumulative runoff at this site for the first 6 months of the 1980

water year was 262 percent of median. In the central part of the State, monthly mean flow of Bad River near Fort Pierre was only 2 percent of median and was below the normal range, following 5 consecutive months with no observed flow at this station.

In eastern North Dakota, where monthly mean flow of Red River of the North at Grand Forks was above the normal range from November 1979 through February 1980, mean discharge increased seasonally but was in the normal range and was 100 percent of the March median discharge. In the southwestern part of the State, mean discharge of Cannonball River at Breien also increased seasonally but was below the normal range as a result of snowmelt runoff that was reported to be generally the lowest since 1964. Cumulative runoff for the first 6 months of the 1980 water year was only 48 percent of median at this station.

In southeastern Saskatchewan, where mean flow of Qu'Appelle River near Lumsden was below the normal range in February, mean discharge increased seasonally and was in the normal range but remained below median for the 5th consecutive month.

In southeastern Manitoba, the level of Lake Winnipeg at Gimli averaged 713.69 feet above mean sea level for the month, the same as in February, 0.31 foot lower than the level of last March, 0.66 foot higher than the long-term mean for March, and 3.98 feet higher than the minimum average level for the month. Records of Lake Winnipeg levels were started in May 1913 at Winnipeg Beach.

#### GROUND-WATER CONDITIONS

In North Dakota, ground-water levels rose statewide but continued slightly below average.

Levels rose statewide in Nebraska and were near long-term averages except locally, where levels were below average in continuing response to heavy ground-water development during last year's irrigation season, or to currently heavy withdrawals in municipal areas.

In Iowa, levels in shallow water-table wells declined in several areas in the east and south; levels rose and were above average farther west in the State.

Levels held fairly steady, for the most part, in Kansas, and most were close to long-term averages. The level in the key well at Colby, at the Kansas Agricultural Experiment Station, declined less than a foot but was at a new low for March in 33 years of record.

In Arkansas, in the rice-growing area in the east-central part of the State, the level in the key well in the shallow Quaternary aquifer declined slightly and continued below average by more than  $6\frac{1}{2}$  feet. The level in the deep Sparta Sand aquifer rose  $2\frac{2}{3}$  feet but was 17 feet below average. In the Sparta Sand aquifer in central and southern Arkansas, the level in the key well at Pine

Bluff declined  $1\frac{1}{2}$  feet and was 37 feet below average, reaching a new March low in 22 years of record.

In Louisiana, levels in wells in the terrace and alluvial aquifers continued to rise seasonally in response to recharge from winter rainfall and from high stream stages. Levels declined in the Sparta Sand and Miocene aquifers. In response to pumping as the irrigation season began in the rice-growing area in southwestern Louisiana, levels in wells in the Chicot aquifer declined less than a foot in the Lafayette area and more than 12 feet in the Eunice area. Levels declined 3–6 feet in Acadia, Jefferson Davis, and Vermillion Parishes; the level in the well at Iowa, La., in Jefferson Davis Parish, declined 3 feet, was more than 22 feet below average, and reached a new low for March in 40 years of record. In the Lake Charles industrial area, levels declined  $\frac{1}{2}$  and  $1\frac{1}{2}$  feet in the "700-foot sand" and "500-foot sand," respectively. Levels in wells in the Evangeline aquifer declined nearly 6 feet at Opelousas but only about  $\frac{1}{2}$  foot near Eunice.

In Texas, the artesian levels in the key well in the Edwards aquifer declined at Austin but continued above average; the level declined but was below average in the key well at San Antonio. The artesian level in the key well in the Evangeline aquifer at Houston rose but was below average. A new alltime low level was reached in the well in the Ogallala aquifer at Plainview, in the Texas Panhandle.

## WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

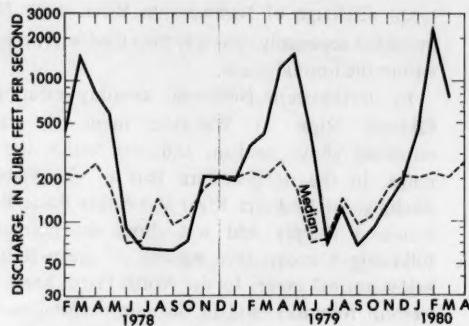
*Streamflow generally decreased in Alberta, Arizona, and Nevada, increased in British Columbia and Montana, and was variable elsewhere in the region. Monthly mean flows remained in the above-normal range in parts of Arizona, California, Colorado, New Mexico, Utah, and Wyoming. Below-normal streamflow persisted in parts of Alberta, Idaho, Montana, Oregon, and Utah, and decreased into that range in parts of Colorado and Wyoming. Heavy snow cover in Utah's mountains represented a potential flood threat in parts of that State.*

*Ground-water levels rose in Utah, generally declined in Montana and New Mexico, and showed mixed trends elsewhere in the region. Levels were below average in Montana, Arizona, and New Mexico, and mostly below average in Idaho; levels were mixed with respect to average elsewhere. New low levels for March were recorded in Idaho, Arizona, and New Mexico, and the*

*low for March in a well in Nevada, reached in 1979, was duplicated again this month. A new high for March was reached in Utah. A new alltime low occurred in Idaho, and a new alltime high was recorded in southern California.*

## STREAMFLOW CONDITIONS

In the Gila River basin in central Arizona, high carryover flow from February held monthly mean discharges at index stations on the Gila River at head of Safford Valley, near Solomon, the Salt River near Roosevelt, and the Verde River below Tangle Creek above Horseshoe Dam, in the above-normal range and between 2 and 4 times the median discharge for the month. Cumulative runoff for the first 6 months of the 1980 water year at those sites ranged from  $4\frac{1}{2}$  to 5 times the median cumulative runoff. Similarly in northeastern Arizona, monthly mean discharge of Little Colorado River near Cameron decreased to 224 percent of median and remained in the above-normal range. Also, in extreme northwestern Arizona and the adjacent areas of Nevada and Utah, mean flow of Virgin River, as measured at Littlefield, Arizona, decreased seasonally from the alltime record high monthly mean discharge in February but remained in the above-normal range at 359 percent of the March median. (See graph.)



Monthly mean discharge of Virgin River at Littlefield, Ariz.  
(Drainage area, 5,090 sq mi; 13,180 sq km)

In southeastern New Mexico, mean flow in Delaware River near Red Bluff decreased seasonally to 260 percent of median but remained in the above-normal range for the 5th consecutive month. Elsewhere in the State, monthly mean discharges at index stations were within the normal range.

In southern California, monthly mean discharge of Arroyo Seco near Pasadena decreased seasonally, was  $15\frac{1}{2}$  times median, and remained in the above-normal range for the 3d consecutive month. Cumulative runoff

at that gaging station for the 6-month period, October 1979 through March 1980, was almost 8 times median. In the southern part of the Sierra Nevada west slope, monthly mean discharge of Kings River above North Fork, near Trimmer, decreased, contrary to the normal seasonal pattern of increasing flows, was twice the median flow for March, and remained in the above-normal range for the 3d consecutive month. Cumulative runoff for the 6-month period ending March 31 at that site was twice the median. In north-coastal California, monthly mean flow of Smith River near Crescent City increased, contrary to the normal seasonal pattern of decreasing flow, and was above the normal range, in sharp contrast to the below-normal flow at that site in February. Elsewhere in the State, mean flows were generally above median and within the normal range. Combined contents of 10 reservoirs in northern California were 113 percent of average and 103 percent of the contents one year ago.

In north-central Nevada, where monthly mean flow of Humboldt River at Palisade was above the normal range and 273 percent of median in February, mean flow decreased and was in the normal range in March.

In Utah, streamflow was below the normal range in the northern part of the State and above the normal range in the southern part. Mean flow of Whiterocks River near Whiterocks, in the northeast, remained in the below-normal range for the 8th consecutive month. Also, monthly mean discharge of Weber River near Oakley increased seasonally to 75 percent of median but remained in the below-normal range for the 7th consecutive month. In the southeastern part of the State, monthly mean flow of San Juan River near Bluff decreased but remained in the above-normal range. National Weather Service reports indicate that the abundant winter snowpack on Utah's mountains represents a potential flood threat in eastern Salt Lake County and western Garfield County.

Contents of the Colorado River Storage Project decreased 17,100 acre-feet during the month.

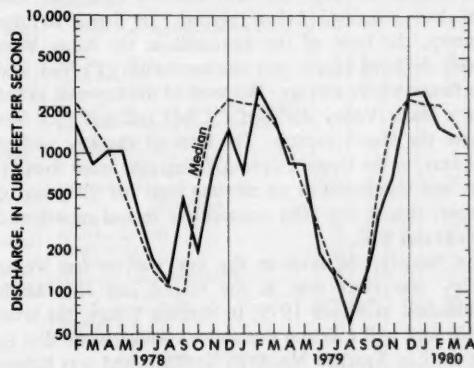
East of the Continental Divide in central Colorado, monthly mean discharge of Bear Creek at Morrison increased seasonally to 158 percent of median and remained in the above-normal range for the 3d consecutive month. Also in central Colorado but west of the Divide, mean flow of Roaring Fork River at Glenwood Springs decreased and was below the normal range, following 4 consecutive months of above-normal flow at that site. In the northwestern part of the State, the seasonal increase in flow from February was only 3 percent compared to a normal increase of 49 percent at Yampa River at Steamboat Springs and the resulting mean flow was below the normal range.

In southern Wyoming, mean flow of North Platte River above Seminoe Reservoir, near Sinclair increased seasonally to 147 percent of median and remained in the above-normal range for the 3d consecutive month. In the northern part of the State, monthly mean discharge of Tongue River near Dayton continued to decrease seasonally and was below the normal range.

In Montana, streamflow was in the normal range except for the Clark Fork and Marias River basins, which were in the below-normal range. Monthly mean flows at all five index stations increased seasonally and cumulative runoff for the first 6 months of the 1980 water year was below the normal range except for the 2 index stations on the Yellowstone River.

In southern Idaho, and the adjacent area of Wyoming, mean flow during March at Snake River near Heise increased slightly but remained in the below-normal range for the 10th consecutive month. Downstream at Weiser, monthly mean discharge of the Snake River decreased seasonally and was below the normal range at 82 percent of median. Streamflow was within the normal range and slightly below median in the Clearwater, Coeur d'Alene, Weiser, and Salmon Rivers, and above the normal range in the Boise River. Reservoir storage for irrigation was near average while storage in northern Idaho reservoirs remained below average.

In extreme northwestern Oregon, where monthly mean flow near Tillamook, in the coastal basin of Wilson River, was only 68 percent of median during February, flow decreased seasonally during March but was within the normal range and 82 percent of median. (See graph.)



Monthly mean discharge of Wilson River near Tillamook, Oreg.  
(Drainage area, 161 sq mi; 417 sq km)

Flow of the Willamette River, as measured at Salem, Oregon, increased but remained in the below-normal range for the 2d consecutive month.

In north-central Washington, streamflow was below the normal range in the Okanogan River near Tonasket, while flow in the Klickitat River near Pitt, in the south-central part of the State, was above the normal range. Elsewhere, flows were generally within the normal range.

In British Columbia, monthly mean flows at both index stations increased, contrary to the normal seasonal pattern of decreasing flow, was below median, but within the normal range at both sites.

In western Alberta, monthly mean flow of Bow River at Banff continued to decrease seasonally, was below median for the 14th consecutive month, and below the normal range for the 11th time in the past 13 months.

#### GROUND-WATER CONDITIONS

In Washington, the artesian ground-water level in the key well at Tacoma, in the western part of the State, rose more than 12 feet and was 2½ feet above average.

In Idaho, the level in the key well in the sand and gravel aquifer in the Boise Valley was slightly above average. Levels in the key wells in the Snake River Plain aquifer were all below average. New lows for March were reached in the wells at Atomic City and at Rupert, in 31 and 30 years of record, respectively. A new alltime low level was recorded in the well at Eden, in 23 years of record.

In Montana, levels declined slightly and were below average, but were higher than those of March 1979.

In southern California, the level of the key well in the Los Alamitos area of Orange County declined 1.62 feet and continued below average. In Los Angeles County, the level of the key well near Baldwin Park rose 7.53 feet but remained below average. In Santa Barbara County, the level of the key well in the Santa Ynez Valley declined barely, just one hundredth of a foot, and continued above average. The level of the key well in the Santa Maria Valley declined 1.7 feet and was 10.1 feet above the March average. The level of the key well at Cuyama, in the Upper Cuyama Valley rose more than 16 feet and continued at an all-time high for 29 years of record; this is the 10th consecutive record month-end high at this well.

In Nevada, the level in the key well in Las Vegas Valley rose, but was at the record low for March established in March 1979. In Steptoe Valley, the level in the key well rose and was above average, while that in the well in Truckee Meadows declined and was below average.

In Utah, levels generally rose statewide. Levels were below average in the Flowell and Holladay areas and above average in the Blanding and Logan areas. The artesian level in the Blanding area well reached a new high for March in 20 years of record.

In Arizona, levels rose in two index wells and declined in three. The level in the Elfrida water-table well in valley fill at Douglas declined slightly but reached a new

low for March in 29 years of record. A new February low also was reached in another index well.

In New Mexico, levels began to decline seasonally during March with the exception of the level in the Lovington water-table well, which showed a net rise of only 0.01 foot. Levels in all the key wells continued below average. The level in the Dayton water-table well declined ¼ foot and reached a new low for March in 42 years of record.

#### ALASKA

Streamflow decreased seasonally at all index stations in the State. Monthly mean flows remained in the above-normal range for the 6th consecutive month at Kenai River at Cooper Landing and Little Susitna River near Palmer as a result of above-normal precipitation and mild winter temperatures. As a result of recomputation of winter flows at the large river station, Tanana River at Nenana, mean flows from November through March were above the normal range with new monthly maximums for the period of record (since 1963) established in December, January, and February. These record-breaking flows were the result of much milder winter temperatures than normal. Cumulative runoff for the first 6 months of the 1980 water year was above the normal range at all index sites except at the interior station, Chena River at Fairbanks.

Ground-water levels in wells tapping confined aquifers were mostly stable in all sectors of Anchorage, except in the far northeast where levels fell about 1 foot.

#### HAWAII

Severe flooding occurred on the Island of Hawaii as a result of rapid runoff from rainfall of as much as 20 inches in 24 hours. Many homes in flood-prone areas were inundated and damage to State and county roads was reported to have been extensive. In Waiakea Stream near Mountain View (drainage area, 17.4 square miles) where the monthly mean discharge in February was 0.22 cfs (3 percent of median), monthly mean discharge in March was 38.6 cfs (290 percent of median) and the daily mean of 195 cfs on the 17th was the highest for the month in 50 years of record. On the Island of Oahu, mean flow of Kaliki Stream near Honolulu increased from the below-normal range and 48 percent of median in February to the above-normal range and 358 percent of median in March. Similarly, on the Island of Maui, monthly mean discharge of Honopou Stream near Huelo increased from the below-normal range and 44 percent of median in February to the above-normal range and 476 percent of median in March. On the Island of Kauai, mean flow of East Branch of North Fork Wailua River near Lihue increased from the below-normal range in February to the normal range in March.

On Guam, Mariana Islands, monthly mean flow of Ylig River near Yona decreased seasonally but remained in the above-normal range as a result of high carryover flow from February.

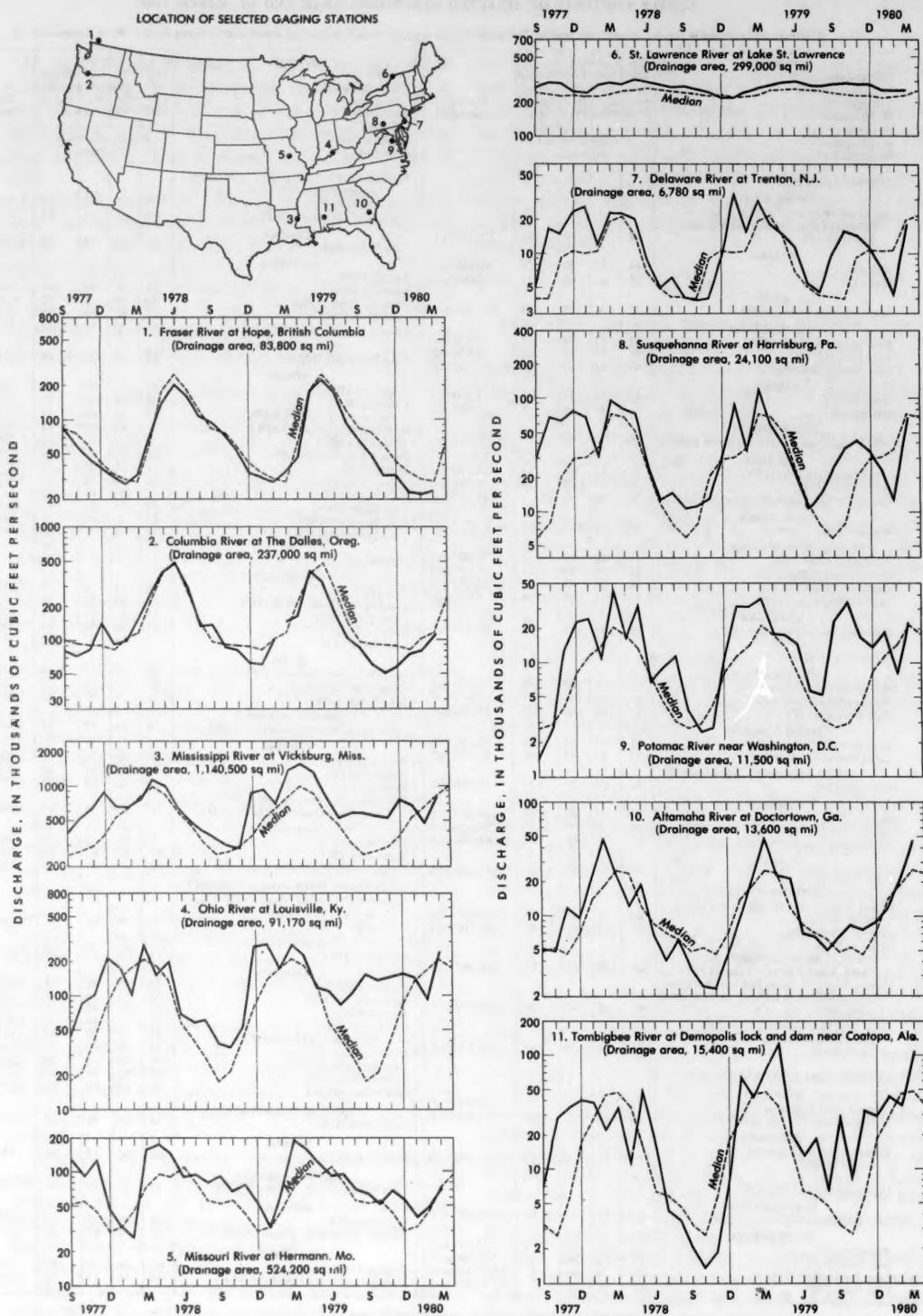
## USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF MARCH 1980

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Principal uses: F—Flood control I—Irrigation M—Municipal P—Power R—Recreation W—Industrial	Reservoir				Normal maximum	Principal uses: F—Flood control I—Irrigation M—Municipal P—Power R—Recreation W—Industrial	Reservoir				Normal maximum	
	End of Feb. 1980	End of Mar. 1980	End of Mar. 1979	Average for end of Mar.			End of Feb. 1980	End of Mar. 1980	End of Mar. 1979	Average for end of Mar.		
	Percent of normal maximum					Percent of normal maximum						
<b>NORTHEAST REGION</b>												
NOVA SCOTIA												
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	54	53	78	63	226,300 (a)	SOUTH DAKOTA—Continued	101	103	102	99	1,725,000 ac-ft	
QUEBEC	44	41	36	29	280,600 ac-ft	Lake Sharpe (FIP)	79	81	75	84	477,000 ac-ft	
Allard (P)	69	61	40	43	6,954,000 ac-ft	Lewis and Clarke Lake (FIP)						
Gouin (P)						NEBRASKA	82	84	70	76	1,948,000 ac-ft	
MAINE						Eufaula (FPR)	81	80	92	85	2,378,000 ac-ft	
Seven reservoir systems (MP)	30	26	59	34	178,500 mcft	Keystone (FPR)	85	90	119	104	661,000 ac-ft	
NEW HAMPSHIRE						Tenkiller Ferry (FPR)	90	90	105	92	628,200 ac-ft	
First Connecticut Lake (P)	44	42	29	14	3,330 mcft	Lake Altus (FMR)	68	69	59	55	133,000 ac-ft	
Lake Francis (FPR)	47	43	32	20	4,326 mcft	Lake O'The Cherokee (FPR)	77	76	89	87	1,492,000 ac-ft	
Lake Winnipesaukee (PR)	62	77	77	63	7,220 mcft	Lake Texoma (FMPRW)	88	83	92	88	2,722,000 ac-ft	
VERMONT						TEXAS						
Harriman (P)	42	58	31	33	5,060 mcft	Bridgeport (IMW)	41	32	38	45	386,400 ac-ft	
Somerset (P)	45	46	70	51	2,500 mcft	Canyon (FMR)	94	94	100	73	385,600 ac-ft	
MASSACHUSETTS						International Amistad (FIMPW)	94	91	106	81	3,497,000 ac-ft	
Cobble Mountain and Borden Brook (MP)	69	90	94	58	3,394 mcft	International Falcon (FIMPW)	89	88	100	73	2,668,000 ac-ft	
NEW YORK						Livingston (IMW)	99	100	100	82	1,788,000 ac-ft	
Great Sacandaga Lake (FPR)	27	57	84	47	34,270 mcft	Possum Kingdom (IMPRW)	86	85	94	96	570,200 ac-ft	
Indian Lake (FMP)	52	56	68	48	4,500 mcft	Red Bluff (PI)	27	25	35	30	307,000 ac-ft	
New York City reservoir system (MW)	78	94	97	.....	547,500 mg	Toledo Bend (P)	96	94	96	85	4,472,000 ac-ft	
NEW JERSEY						Twin Buttes (FIM)	42	38	67	30	177,800 ac-ft	
Wanaque (M)	90	102	101	90	27,730 mg	Lake Kemp (IMW)	54	51	56	87	268,000 ac-ft	
PENNSYLVANIA						Lake Meredith (FWM)	27	27	32	37	821,300 ac-ft	
Allegheny (FPR)	29	42	47	34	51,400 mcft	Lake Travis (FIMPRW)	88	91	93	80	1,144,000 ac-ft	
Pymatuning (FMR)	86	98	98	93	8,191 mcft	THE WEST						
Raystown Lake (FPR)	48	68	70	52	33,190 mcft	WASHINGTON						
Lake Wallenpaupack (PR)	50	73	68	64	6,875 mcft	Ross (PR)	18	13	29	28	1,052,000 ac-ft	
MARYLAND						Franklin D. Roosevelt Lake (IP)	44	30	43	46	5,022,000 ac-ft	
Baltimore municipal system (M)	98	100	101	93	85,340 mg	Lake Chelan (PR)	26	14	21	31	676,100 ac-ft	
SOUTHEAST REGION						Lake Cushman	89	92	83	84	359,500 ac-ft	
NORTH CAROLINA						Lake Merwin (P)	94	106	97	97	245,600 ac-ft	
Bridgewater (Lake James) (P)	75	91	100	90	12,580 mcft	IDaho						
Narrows (Badin Lake) (P)	87	100	100	101	5,616 mcft	Boise River (4 reservoirs) (FIP)	57	66	79	66	1,235,000 ac-ft	
High Rock Lake (P)	41	100	100	83	10,230 mcft	Coeur d'Alene Lake (P)	34	33	72	72	238,500 ac-ft	
SOUTH CAROLINA						Pend Oreille Lake (FP)	36	10	37	52	1,561,000 ac-ft	
Lake Murray (P)	81	95	90	78	70,300 mcft	IDaho—WYOMING						
Lakes Marion and Moultrie (P)	72	87	87	80	81,100 mcft	Upper Snake River (8 reservoirs) (MP)	76	83	77	74	4,401,000 ac-ft	
SOUTH CAROLINA—GEORGIA						WYOMING						
Clark Hill (FP)	70	99	81	73	75,360 mcft	Boysen (FIP)	70	69	71	63	802,000 ac-ft	
GEORGIA						Buffalo Bill (IP)	51	51	51	60	421,300 ac-ft	
Burton (PR)	63	99	89	83	104,000 ac-ft	Keyhole (F)	75	74	80	47	190,400 ac-ft	
Sinclair (MPR)	88	101	79	89	214,000 ac-ft	Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Gruene Reservoirs (I)	60	62	56	48	3,056,000 ac-ft	
Lake Sidney Lanier (FMPR)	63	77	65	60	1,686,000 ac-ft	COLORADO						
ALABAMA						John Martin (FIR)	9	11	4	18	364,400 ac-ft	
Lake Martin (P)	75	101	91	89	1,373,000 ac-ft	Taylor Park (IR)	67	67	52	55	106,200 ac-ft	
TENNESSEE VALLEY						Colorado—Big Thompson project (I)	66	67	41	54	722,600 ac-ft	
Clinch Projects: Norris and Melton Hill Lakes (FPR)	40	64	59	53	1,156,000 cfsd	COLORADO RIVER STORAGE PROJECT						
Douglas Lake (FPR)	20	58	47	43	703,100 cfsd	Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	79	79	64	.....	31,620,000 ac-ft	
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parks Valley Lakes (FPR)	48	126	68	64	510,300 cfsd	UTAH—IDAHO						
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	49	68	66	56	1,452,000 cfsd	Bear Lake (IPR)	71	73	73	59	1,421,000 ac-ft	
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	46	79	70	63	745,200 cfsd	CALIFORNIA						
WESTERN GREAT LAKES REGION						Folsom (FIP)	68	70	80	61	1,000,000 ac-ft	
WISCONSIN						Hetch Hetchy (MP)	58	55	36	26	360,400 ac-ft	
Chippewa and Flambeau (PR)	41	34	31	25	15,900 mcft	Isabella (FIR)	66	66	48	25	568,100 ac-ft	
Wisconsin River (21 reservoirs) (PR)	26	15	37	24	17,400 mcft	Pine Flat (FI)	90	72	83	54	1,001,000 ac-ft	
MINNESOTA						Clair Engle Lake (Lewiston) (P)	88	87	70	82	2,438,000 ac-ft	
Mississippi River headwater system (FMR)	18	18	19	19	1,640,000 ac-ft	Lake Almanor (P)	74	80	67	52	1,036,000 ac-ft	
MIDCONTINENT REGION						Lake Berryessa (FIMW)	90	96	78	88	1,600,000 ac-ft	
NORTH DAKOTA						Millerton Lake (FI)	87	65	94	65	503,200 ac-ft	
Lake Sakakawea (Garrison) (FIPR)	82	81	79	84	22,700,000 ac-ft	Shasta Lake (FIPR)	90	87	94	83	4,377,000 ac-ft	
SOUTH DAKOTA						CALIFORNIA—NEVADA						
Angostura (I)	99	100	99	82	127,600 ac-ft	Lake Tahoe (IPR)	34	43	19	55	744,600 ac-ft	
Bell Fourche (I)	52	59	88	63	185,200 ac-ft	NEVADA						
Lake Francis Case (FIP)	73	78	86	82	4,834,000 ac-ft	Rye Patch (I)	63	80	43	66	194,300 ac-ft	
Lake Oahe (FIP)	84	86	89	.....	ARIZONA—NEVADA							
					Lake Mead and Lake Mohave (FIMP)	88	89	88	65	27,970,000 ac-ft		
					San Carlos (IP)	100	96	96	20	1,073,000 ac-ft		
					Salt and Verde River system (IMPR)	80	94	97	48	2,073,000 ac-ft		
					NEW MEXICO							
					Conchas (FIR)	46	46	26	82	330,100 ac-ft		
					Elephant Butte and Caballo (FIPR)	44	43	13	29	2,453,000 ac-ft		

<sup>a</sup>Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

## HYDROGRAPHS OF SOME LARGE RIVERS, SEPTEMBER 1977 TO MARCH 1980



## FLOW OF LARGE RIVERS DURING MARCH 1980

Station number*	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1975 (cfs)	March 1980				Discharge near end of month		
				Monthly discharge (cfs)	Percent of median monthly discharge, 1941-70	Change in discharge from previous month (percent)				
				(cfs)	(mgd)	Date				
1-0140	St. John River below Fish River at Fort Kent, Maine . . . . .	5,690	9,549	1,716	73	+32	3,500	2,300	31	€
1-3185	Hudson River at Hadley, N.Y. . . . .	1,664	2,853	2,753	93	+174	4,000	2,600	31	
1-3575	Mohawk River at Cohoes, N.Y. . . . .	3,456	5,630	11,064	104	+525	.....	.....	.....	
1-4635	Delaware River at Trenton, N.J. . . . .	6,780	11,630	18,410	94	+321	40,700	26,300	26	
1-5705	Susquehanna River at Harrisburg, Pa . . . . .	24,100	34,200	67,080	92	+416	135,000	87,300	25	
1-6465	Potomac River near Washington, D.C. . . . .	11,560	11,190	22,290	106	+170	18,600	12,000	31	
2-1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C. . . . .	4,810	5,007	13,000	146	+135	17,000	11,000	31	
2-1310	Pee Dee River at PeeDee, S.C. . . . .	8,830	9,657	19,300	136	+38	33,600	21,700	26	
2-2260	Altamaha River at Doctortown, Ga . . . . .	13,600	13,780	46,860	183	+125	60,800	39,300	31	
2-3205	Suwannee River at Branford, Fla . . . . .	7,880	6,970	10,700	108	+32	15,400	9,950	31	
2-3580	Apalachicola River at Chattahoochee, Fla . . . . .	17,200	22,330	61,200	158	+134	87,000	56,200	31	
2-4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala . . . . .	15,400	22,570	115,800	239	+213	184,000	119,000	31	
2-4895	Pearl River near Bogalusa, La. . . . .	6,630	9,263	30,290	173	+9	106,000	68,500	31	
3-0495	Allegheny River at Natrona, Pa . . . . .	11,410	19,210	31,580	87	+186	37,700	24,400	25	
3-0850	Monongahela River at Braddock, Pa . . . . .	7,337	12,360	25,930	122	+196	20,800	13,400	25	
3-1930	Kanawha River at Kanawha Falls, W.Va . . . . .	8,367	12,530	32,130	144	+138	55,200	35,700	23	
3-2345	Scioto River at Higby, Ohio . . . . .	5,131	4,513	11,540	129	+222	14,700	9,500	25	
3-2945	Ohio River at Louisville, Ky <sup>2</sup> . . . . .	91,170	114,100	247,100	112	+145	375,900	243,000	25	
3-3775	Wabash River at Mount Carmel, Ill . . . . .	28,635	27,030	60,420	120	+154	82,000	53,000	31	
3-4690	French Broad River below Douglas Dam, Tenn . . . . .	4,543	6,794	15,509	143	+120	.....	.....	.....	
4-0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis <sup>2</sup> . . . . .	6,150	4,185	2,260	53	-48	.....	.....	.....	
02MC002 (4-2643,31)	St. Lawrence River at Cornwall, Ontario—near Massena, N.Y. <sup>3</sup> . . . . .	299,000	241,100	252,600	109	0	246,000	159,000	31	
050115	St. Maurice River at Grand Mere, Quebec . . . . .	16,300	25,300	6,160	50	+319	21,800	14,100	31	
5-0825	Red River of the North at Grand Forks, N. Dak . . . . .	30,100	2,524	1,582	100	+14	2,000	1,300	31	
5-1335	Rainy River at Manitou Rapids, Minn . . . . .	19,400	12,950	8,240	90	-21	7,950	5,140	24	
5-3300	Minnesota River near Jordan, Minn . . . . .	16,200	3,412	4,630	164	+267	9,800	6,300	24	
5-3310	Mississippi River at St. Paul, Minn . . . . .	36,800	10,580	10,590	140	+69	16,900	10,900	24	
5-3655	Chippewa River at Chippewa Falls, Wis . . . . .	5,600	5,110	3,860	90	+42	.....	.....	.....	
5-4070	Wisconsin River at Muscoda, Wis . . . . .	10,300	8,613	8,192	90	+16	.....	.....	.....	
5-4465	Rock River near Joslin, Ill . . . . .	9,551	5,852	6,810	70	+19	6,200	4,010	31	
5-4745	Mississippi River at Keokuk, Iowa . . . . .	119,000	62,570	72,370	86	+58	93,100	60,200	31	
6-2145	Yellowstone River at Billings, Mont . . . . .	11,796	6,986	3,104	104	+23	2,950	1,910	31	
6-9345	Missouri River at Hermann, Mo . . . . .	524,200	79,750	70,030	95	+43	73,400	47,400	25	
7-2890	Mississippi River at Vicksburg, Miss <sup>4</sup> . . . . .	1,140,500	573,600	783,800	96	+66	1,050,000	679,000	24	
7-3310	Washita River near Durwood, Okla . . . . .	7,202	1,414	246	36	-30	242	156	31	
8-2765	Rio Grande below Taos Junction Bridge, near Taos, N. Mex . . . . .	9,730	724	583	104	+5	605	391	31	
9-3150	Green River at Green River, Utah . . . . .	40,600	6,366	4,080	105	+46	3,280	2,120	31	
11-4255	Sacramento River at Verona, Calif . . . . .	21,257	19,150	47,870	156	+8	24,000	15,500	27	
13-2690	Snake River at Weiser, Idaho . . . . .	69,200	18,170	14,400	82	-6	13,900	8,980	24	
13-3170	Salmon River at White Bird, Idaho . . . . .	13,550	11,290	4,950	98	+23	4,690	3,030	24	
13-3425	Clearwater River at Spalding, Idaho . . . . .	9,570	15,570	8,910	71	+25	9,600	6,200	24	
14-1057	Columbia River at The Dalles, Ore <sup>5</sup> . . . . .	237,000	194,600	110,400	95	+37	.....	.....	.....	
14-1910	Willamette River at Salem, Ore . . . . .	7,280	23,810	24,450	76	+1	22,990	14,900	26-31	
15-5155	Tanana River at Nenana, Alaska . . . . .	25,600	23,850	7,361	125	-4	7,200	4,650	21	
8MF005	Fraser River at Hope, British Columbia . . . . .	83,800	96,400	23,800	85	+6	21,900	14,200	29	

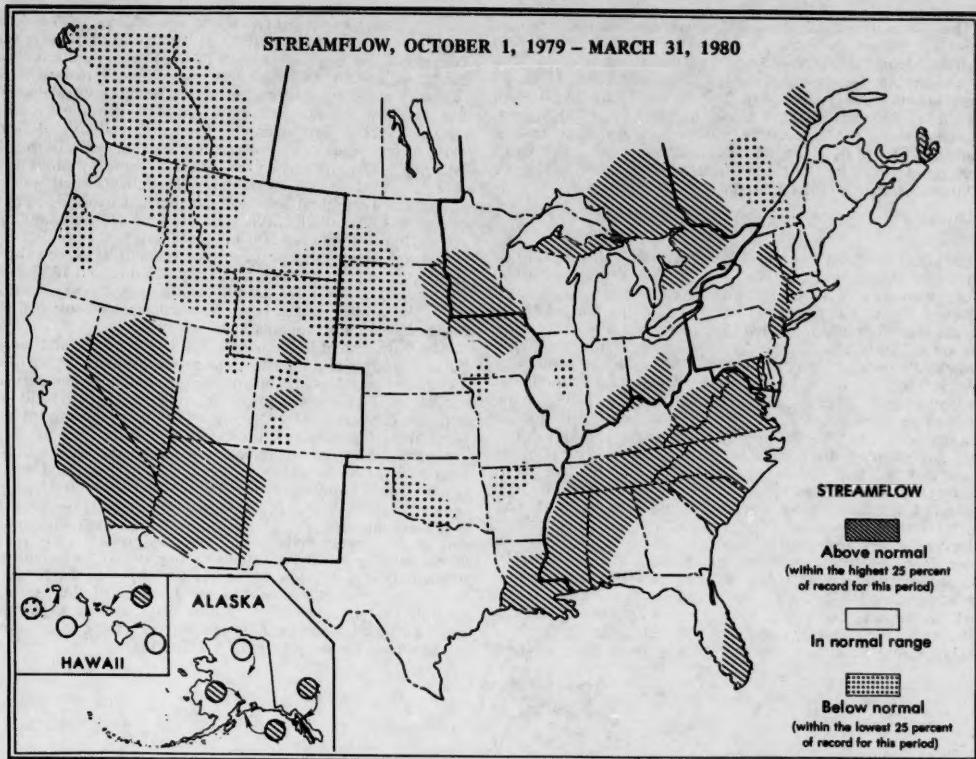
<sup>1</sup> Adjusted.<sup>2</sup> Records furnished by Corps of Engineers.<sup>3</sup> Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.<sup>4</sup> Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.<sup>5</sup> Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.<sup>\*</sup>The U.S. station numbers as listed in this table are in a shortened form previously in use, and used here for simplicity of tabular and map presentation. The full, correct number contains 8 digits and no punctuation marks. For example, the correct form for station number 1-3185 is 01318500.

## DISSOLVED SOLIDS AND WATER TEMPERATURES FOR MARCH AT DOWNSTREAM SITES ON SIX LARGE RIVERS

Station number	Station name	March data of following calendar years	Stream discharge during month	Dissolved-solids concentration during month <sup>a</sup>			Dissolved-solids discharge during month <sup>a</sup>			Water temperature during month <sup>b</sup>		
				Mean (cfs)	Minimum (mg/l)	Maximum (mg/l)	Mean (tons per day)	Minimum	Maximum	Mean, in °C	Minimum, in °C	Maximum, in °C
01463500	NORTHEAST Delaware River at Trenton, N.J. (Morristown, Pa.)	1980 1945-79 (Extreme yr)	20,200 20,970	63 44 (1945)	136 123 (1978)	4,360 .....	1,100 1,250 (1969)	15,000 98,100 (1978)	5,5 .....	2,0 0	8.5 15.0	
04264331	St. Lawrence River at Cornwall, Ontario; near Massena, N.Y. median streamflow at Odgensburg, N.Y.	1980 1976-79 (Extreme yr)	252,300 276,200	166 164 (1977)	167 170 (1979)	113,000 124,000	106,000 94,000 (1977)	117,000 145,000 (1978)	0.5 0.5	0.5 0	1.5 2.0	
07289000	SOUTHEAST Mississippi River at Vicksburg, Miss.	1980 1976-79 (Extreme yr)	7,3,800 942,300	183 166 (1979)	254 234 (1977)	447,000 478,000	316,000 215,000 (1977)	540,000 803,000 (1979)	8.5 10.0	6.0 5.0	11.0 14.0	
03612500	WESTERN GREAT LAKES REGION Ohio River at lock and dam 53, near Grand Chain, Ill. (25 miles west of Paducah, Ky.; streamflow station at Metropolis, Ill.)	1980 1955-79 (Extreme yr)	626,000 565,400 (1955, 1964)	153 128 (1968)	194 312 (1968)	.....	107,000 54,000 (1968)	410,000 776,000 (1979)	.....	4.5 0.5	10.0 14.5	
06934500	MIDCONTINENT Missouri River at Hermann, Mo. (60 miles west of St. Louis, Mo.)	1980 1976-79 (Extreme yr)	71,400 121,300 (1978)	283 186 (1978)	401 404 (1976)	64,900 87,900	47,200 29,300 (1977)	82,500 199,000 (1979)	6.5 7.0	2.5 0	10.0 13.0	
14128910	WEST Columbia River at Warrendale, Oreg. (streamflow station at The Dalles, Oreg.)	1980 1976-79 (Extreme yr)	140,300 170,100 (1976)	87 97 (1976)	118 126 (1979)	41,000 48,800 (1977)	25,600 27,200 (1977)	59,800 73,300 (1976)	6.5 6.0	4.5 3.0	8.0 8.0	

<sup>a</sup>Dissolved-solids concentrations when not analyzed directly, are calculated on basis of measurements of specific conductance.<sup>b</sup>To convert °C to °F:  $(1.8 \times ^\circ C) + 32 = ^\circ F$ .<sup>c</sup>Median of monthly values for 30-year reference period, water years 1941-70, for comparison with data for current month.

## SUPPLEMENTAL DATA FOR SIX-MONTH PERIOD ENDING MARCH 31, 1980



### WATER RESOURCES REVIEW

March 1980

Based on reports from the Canadian and U.S. field offices; completed April 11, 1980

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#### EXPLANATION OF DATA

*Cover map* shows generalized pattern of streamflow for February based on 20 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for March 1980 is compared with flow for March in the 30-year reference period 1941-70. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for March is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being *within the normal range*. In the Water Resources Review the median is obtained by ranking the 30 flows of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median.

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the March flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of March. Water level in each key observation well is compared with average level for the end of March determined from the entire past record for that well or from a 20-year reference period, 1951-70. *Changes in ground-water levels*, unless described otherwise, are from the end of February to the end of March.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. Issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Reston, Virginia 22092.

## LEACHATE PLUMES IN GROUND WATER FROM BABYLON AND ISLIP LANDFILLS, LONG ISLAND, NEW YORK

The abstract and illustrations below are from the report, *Leachate plumes in ground water from Babylon and Islip landfills, Long Island, New York*, by Grant E. Kimmel and Olin C. Braids; U.S. Geological Survey Professional Paper 1085, 38 pages, 1980. This report may be purchased for \$3.50 from Branch of Distribution, U.S. Geological Survey, 1200 S. Eads St., Arlington, Va. 22202 (check or money order payable to U.S. Geological Survey); or from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (payable to Superintendent of Documents).

### ABSTRACT

Landfills operated by the Towns of Babylon and Islip in southwest and central Suffolk County (fig. 1) contain urban refuse, incinerated garbage, and scavenger (cesspool) waste; some industrial refuse is deposited at the Babylon site. The Islip landfill was started in 1933, the Babylon landfill in 1947. The landfills are in contact with and discharge leachate into the highly permeable upper glacial aquifer (hydraulic conductivity 190–500 feet per day). The aquifer is 74 feet thick at the Babylon landfill and 170 feet thick at the Islip landfill. The leachate-enriched water occupies the entire thickness of the aquifer beneath both landfills, but hydrologic boundaries retard downward migration of the plumes to deeper aquifers. The Babylon plume is 1,900 feet wide at the landfill and narrows to about 700 feet near its terminus 10,000 feet from the landfill. The Islip plume is 1,400 feet wide at the landfill and narrows to 500 feet near its terminus 5,000 feet from the landfill. (See figure 2.)

Hydrochemical maps and sections show the distribution of the major chemical constituents of the plumes. The most highly leachate-enriched ground water obtained was from the Babylon site; it contained 860 mg/L (milligrams per liter) sodium, 110 mg/L potassium, 565 mg/L calcium, 100 mg/L magnesium, 2,700 mg/L bicarbonate, and 1,300 mg/L chloride. Sulfate was notably absent or in low concentration in most parts of both

plumes. Nitrogen in plume water was mostly in the form of ammonium, and concentrations as high as 90 mg/L were found; concentrations of nitrogen as N in the plume were less than 10 mg/L. As much as 440 mg/L iron and 190 mg/L manganese were found in the leachate-enriched water. Samples were also tested for arsenic, boron, cadmium, cobalt, chromium, copper, mercury, nickel, lead, selenium, strontium, and zinc. Boron was more or less ubiquitous and was found in concentrations as high as 2 mg/L. Organic carbon was found in concentrations as high as 2,250 mg/L in the most highly leachate-enriched water but attenuated rapidly to less than 20 mg/L. Dissolved-solids concentrations near the landfills were between 400 and 3,000 mg/L at Babylon and between 500 and 1,500 mg/L at Islip.

Ground-water temperatures near the landfills exceed those in ambient water by as much as 7°C at Babylon and 16°C at Islip. Heat contributed by the landfills was mostly dissipated with 0.4 mi of the landfill, but at Islip, the warm leachate-enriched water extended 0.5 mi downgradient.

The entrance of leachate into the less dense ground water as pulsations after rainfall may explain the presence of high leachate enrichment near the bottom of the aquifer. A comparison of the physical characteristics of leachate-enriched ground water with those of ambient water suggests that the downward movement of leachate results from its greater density.

Simulation of the movement and dispersion of the Babylon plume with a mathematical dispersion model indicated the coefficient of longitudinal dispersion to be about 60 ft<sup>2</sup>/d (feet squared per day) and the ground-water velocity to be 1 ft/d. However, the velocity determined from the hydraulic gradient and public-supply wells in the area was 4 ft/d; this velocity would cause a plume four times as long as that predicted by the mathematical dispersion model. At the Islip site, the plume was one-third the length calculated on the basis of the age of the landfill. The shortness of the plumes has not been explained; it may be a result of the leachate's having been too dilute to form a plume during the early years of the landfills.

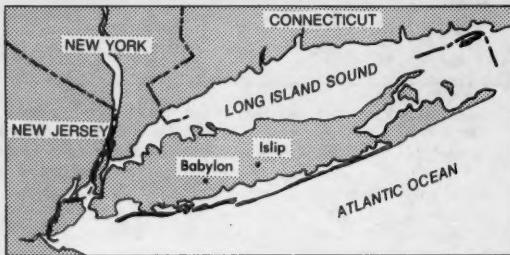


Figure 1.—Long Island, New York, showing locations of Babylon and Islip landfills.

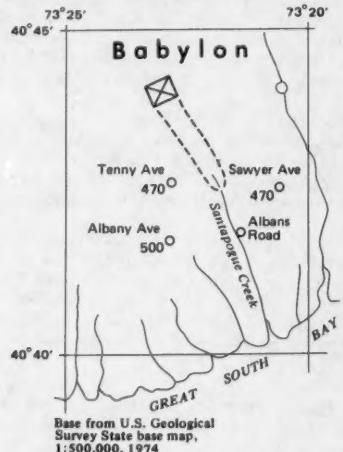


Figure 2.—Maps of the Babylon and Islip landfill areas, showing hydraulic conductivity at selected nearby public-supply-well stations in the upper glacial aquifer. Also shown are landfill locations and the approximate extent of leachate plumes.

